

What is claimed is:

- [c1] 1. A heat sink assembly for cooling a device using circulating fluid, the heat sink assembly comprising:
- a housing including at least one housing inlet passage and at least one housing outlet passage;
 - a first cavity disposed in the housing, the first cavity including a first cavity top surface and including a first cavity bottom surface opposed to the first cavity top surface, the first cavity further including a first cavity inlet side adjacent a first cavity inlet and a first cavity outlet side adjacent a first cavity outlet, the first cavity inlet in fluid communication with the at least one housing inlet passage;
 - a plurality of first cavity column members disposed in the first cavity, the first cavity column members connected to and extending from the first cavity bottom surface to proximate the first cavity top surface, the first cavity column members arranged in a plurality of rows such that first cavity column members in a row are staggered with respect to first cavity column members in an adjacent row;
 - a second cavity disposed in the housing, the second cavity including a second cavity top surface and including a second cavity bottom surface opposed to the second cavity top surface, the second cavity further including a second cavity inlet side adjacent to a second cavity inlet and a second cavity outlet side adjacent to a second cavity outlet, the first cavity outlet in fluid communication with the second cavity inlet through an interim connecting fluid path, and the second cavity outlet in fluid communication with the at least one housing outlet passage; and
 - a plurality of second cavity column members disposed in the second cavity, the second cavity column members connected to and extending from the second cavity bottom surface to proximate the second cavity top surface, the second cavity column members arranged in a plurality of rows such that second cavity column members in a row are staggered with respect to second cavity column members in an adjacent row.

- [c2] 2. The heat sink assembly according to claim 1, wherein the interim connecting

fluid path is an interim connecting passage that directly connects the first cavity outlet to the second cavity inlet.

- [c3] 3.The heat sink assembly according to claim 2, wherein the interim connecting passage is defined in part by a portion of the housing.
- [c4] 4.The heat sink assembly according to claim 1, wherein the housing includes: a housing inlet portion that includes the at least one housing inlet passage, and wherein the first cavity and the plurality of first cavity column members each being disposed in the housing inlet portion; and a housing outlet portion that includes the at least one housing outlet passage, and wherein the second cavity and the plurality of second cavity column members each being disposed in the housing outlet portion; and wherein the housing inlet portion and the housing outlet portion are matingly engageable.
- [c5] 5.The heat sink assembly according to claim 4, wherein the at least one housing inlet passage includes two housing inlet passages.
- [c6] 6.The heat sink assembly according to claim 4, wherein the at least one housing outlet passage includes two housing outlet passages.
- [c7] 7.The heat sink assembly according to claim 4, wherein the housing inlet portion including a groove extending around at least a portion of an upper surface of the housing inlet portion; and the housing outlet portion including a lower surface forming a plateau having a periphery with a peripheral edge defining the periphery, the peripheral edge of the plateau matingly engageable with the groove of the housing inlet portion.
- [c8] 8. The heat sink assembly portion according to claim 7, the groove of the housing inlet portion extending along three of four sides of the housing inlet portion, and an elongated aperture disposed along a fourth side of the housing inlet portion, the elongated aperture forming a part of the interim connecting fluid passage.
- [c9] 9. The heat sink assembly according to claim 4, wherein the interim connecting

fluid path includes:

a third cavity disposed in the housing inlet portion, the third cavity including a third cavity top surface and including a third cavity bottom surface opposed to the third cavity top surface, the third cavity further including a third cavity inlet side adjacent to a third cavity inlet and a third cavity outlet side adjacent to a third cavity outlet, the third cavity inlet in fluid communication with the first cavity outlet, and the third cavity outlet in fluid communication with the second cavity inlet through a portion of the interim connecting fluid path; and a plurality of third cavity column members disposed in the third cavity, the third cavity column members connected to and extending from the third cavity bottom surface to proximate the third cavity top surface, the third cavity column members arranged in a plurality of rows such that third cavity column members in a row are staggered with respect to third cavity column members in an adjacent row.

[c10] 10. The heat sink assembly portion according to claim 9, including a first separation wall having opposing sides, the opposing sides of the first separation wall defining the first cavity top surface and the third cavity bottom surface, respectively.

[c11] 11. The heat sink assembly portion according to claim 10, wherein the first separation wall is integrally formed with the housing inlet portion.

[c12] 12. The heat sink assembly according to claim 11, wherein the interim connecting fluid path further includes a fourth cavity disposed in the housing inlet portion, the fourth cavity including a fourth cavity top surface and including a fourth cavity bottom surface opposed to the fourth cavity top surface, the fourth cavity further including a fourth cavity inlet side adjacent to a fourth cavity inlet and a fourth cavity outlet side adjacent to a fourth cavity outlet, the fourth cavity inlet in fluid communication with the third cavity outlet, and the fourth cavity outlet in fluid communication with the second cavity inlet through a portion of the interim connecting fluid path; and a plurality of fourth cavity column members disposed in the fourth cavity, the fourth cavity column members connected to and extending from the fourth

cavity bottom surface to proximate the fourth cavity top surface, the fourth cavity column members arranged in a plurality of rows such that fourth cavity column members in a row are staggered with respect to fourth cavity column members in an adjacent row.

- [c13] 13.The heat sink assembly portion according to claim 12, including a second separation wall having opposing sides, the opposing sides of the second separation wall defining the third cavity top surface and the fourth cavity bottom surface, respectively.
- [c14] 14. The heat sink assembly portion according to claim 13, wherein the first separation wall being integrally formed with the housing inlet portion.
- [c15] 15.The heat sink assembly according to claim 12, wherein the first cavity column members are aligned with the second cavity column members.
- [c16] 16.The heat sink assembly according to claim 12, wherein the first cavity column members are aligned with the third cavity column members; and the third cavity column members are aligned with the fourth cavity column members.
- [c17] 17.The heat sink assembly according to claim 16, wherein the first cavity column members are aligned with the second cavity column members.
- [c18] 18.The heat sink assembly portion according to claim 12, wherein:
the first cavity outlet is connected to the third cavity inlet by a first elongated aperture extending along the length of each of the first cavity outlet side and the third cavity inlet side; and
the third cavity outlet is connected to the fourth cavity inlet by a second elongated aperture extending along the length of each of the third cavity outlet side and the fourth cavity inlet side.
- [c19] 19.The heat sink assembly portion according to claim 18, wherein the first elongated aperture and the second elongated aperture are each formed in part by the housing inlet portion.
- [c20] 20.The heat sink assembly portion according to claim 19, wherein the second

elongated aperture is disposed above and proximate to the first cavity inlet.

- [c21] 21. The heat sink assembly portion according to claim 18, wherein the fourth cavity outlet is connected to a third elongated aperture extending along the length of the fourth cavity outlet side.
- [c22] 22. The heat sink assembly portion according to claim 21, wherein the third elongated aperture is disposed above and proximate to the first elongated aperture.
- [c23] 23. The heat sink assembly according to claim 1, wherein the first cavity column members are aligned with the second cavity column members, each of the first cavity column members and the second cavity column members being cylindrical in shape.
- [c24] 24. The heat sink assembly according to claim 1, wherein each of the first cavity column members extend along a z-dimension from the first cavity bottom surface toward the first cavity top surface and possess a cross-sectional area disposed in an x-y plane, each of the first cavity column members possessing an x-dimension and each the first cavity column members possessing a y-dimension.
- [c25] 25. The heat sink assembly according to claim 24, wherein the cross-sectional area of each of the first cavity column members defines a circle in the x-y plane.
- [c26] 26. The heat sink assembly according to claim 24, wherein the cross-sectional area of each of the first cavity column members defines an elliptical in the x-y plane.
- [c27] 27. The heat sink assembly according to claim 24, wherein a z-dimension of each of the first cavity column members is smaller than either the x-dimension or the y-dimension of the first cavity column members.
- [c28] 28. The heat sink assembly according to claim 24, wherein each of the second cavity column members extend along a z-dimension from the second cavity bottom surface toward the second cavity top surface and possess a cross-

sectional area disposed in an x-y plane, an x-dimension of each of the second cavity column members being substantially equal to a y-dimension of each the second cavity column members, respectively.

- [c29] 29.The heat sink assembly portion according to claim 1, further including:
an inlet conduit connected to the inlet passage of the housing; and
an outlet conduit connected to the outlet passage of the housing.
- [c30] 30.The heat sink assembly portion according to claim 1, wherein the first cavity inlet side directly opposes the first cavity outlet side such that fluid passing from the first cavity inlet to the first cavity outlet passes by the first cavity column members, and
the first cavity inlet disperses the flow of fluid along a length of the first cavity inlet side; and
the first cavity outlet provides for outlet of the flow of fluid along a length of the first cavity outlet side.
- [c31] 31.The heat sink assembly portion according to claim 30, wherein:
the first cavity inlet includes a plurality of inlet conduits along the length of the first cavity inlet side; and
the first cavity outlet is an elongated aperture extending along a length of the first cavity outlet side.
- [c32] 32.The heat sink assembly portion according to claim 1, wherein the heat sink assembly further includes the device that is cooled, the housing engaged with the device.
- [c33] 33.The heat sink assembly portion according to claim 32, wherein the device is an electrical component.
- [c34] 34.The heat sink assembly portion according to claim 1, wherein
the first cavity column members contact, and are connected to, the first cavity top surface; and
the second cavity column members contact, and are connected to, the second cavity top surface.

[c35] 35.The heat sink assembly portion according to claim 1, wherein each of the at least one housing inlet passage and each of the at least one housing outlet passage are all disposed on the same side of the housing.

[c36] 36.The heat sink assembly portion according to claim 1, wherein the fluid is air.

[c37] 37.The heat sink assembly portion according to claim 1, wherein the fluid is water.

[c38] 38.A heat sink assembly for cooling a device using circulating fluid, the heat sink assembly comprising:

- a housing including at least one housing inlet passage and at least one housing outlet passage;
- a first cavity disposed in the housing, the first cavity including a first cavity top surface and including a first cavity bottom surface opposed to the first cavity top surface, the first cavity further including a first cavity inlet side adjacent a first cavity inlet and a first cavity outlet side adjacent a first cavity outlet, the first cavity inlet in fluid communication with the at least one housing inlet passage;
- a plurality of first cavity column members disposed in the first cavity, the first cavity column members connected to and extending from the first cavity bottom surface to proximate the first cavity top surface, the first cavity column members arranged in a plurality of rows such that first cavity column members in a row are staggered with respect to first cavity column members in an adjacent row, the first cavity column members being connected to the first cavity top surface;
- a second cavity disposed in the housing, the second cavity including a second cavity top surface and including a second cavity bottom surface opposed to the second cavity top surface, the second cavity further including a second cavity inlet side adjacent to a second cavity inlet and a second cavity outlet side adjacent to a second cavity outlet, the first cavity outlet in fluid communication with the second cavity inlet through an interim connecting fluid path, and the second cavity outlet in fluid communication with the at least one housing outlet passage; and

a plurality of second cavity column members disposed in the second cavity, the second cavity column members connected to and extending from the second cavity bottom surface to proximate the second cavity top surface, the second cavity column members arranged in a plurality of rows such that second cavity column members in a row are staggered with respect to second cavity column members in an adjacent row, the second cavity column members connected to the second cavity top surface;

wherein the housing includes:

a housing inlet portion that includes the at least one housing inlet passage, and wherein the first cavity and the plurality of first cavity column members each being disposed in the housing inlet portion; and
a housing outlet portion that includes the at least one housing outlet passage, and wherein the second cavity and the plurality of second cavity column members each being disposed in the housing outlet portion; and

wherein the housing inlet portion and the housing outlet portion are matingly engageable, the housing inlet portion including a groove extending around at least a portion of an upper surface of the housing inlet portion;
the housing outlet portion including a lower surface forming a plateau having a periphery with a peripheral edge defining the periphery, the peripheral edge of the plateau matingly engageable with the groove of the housing inlet portion;
and an inlet conduit connected to the inlet passage of the housing; and an outlet conduit connected to the outlet passage of the housing;

wherein the first cavity inlet side directly opposes the first cavity outlet side such that fluid passing from the first cavity inlet to the first cavity outlet passes by the first cavity column members, and the first cavity inlet disperses the flow of fluid along a length of the first cavity inlet side, and the first cavity outlet provides for outlet of the flow of fluid along a length of the first cavity outlet side; and

the heat sink assembly further includes an electrical component that is cooled, the housing engaged with the electrical component.